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JOURNAL

OF THE

AMERICAN WELDING SOCIETY

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American Welding Society

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Volume 1 March, 1922 Number 3

TABLE OF CONTENTS

Society and Related Activities

Page

Program Annual Meeting 3
Welding Conference Committee Completes Report 5
First Annual Dinner of American Welding Society 5
Bureau of Standards Bulletin 5
Research Activities 6
Section News 9
New Members 11
Employment Service 12

Technical Papers, Items and Reports

Boiler Welding 13
Automatic Seam Welding 26
Technical Question and Answer Column 35
Welding Tubes in Boilers 35
Discussion of Papers 38
Cast Iron Welding 38
Welding of Chilled Cast Iron Roll 40
Current Welding Literature 43

The American Welding Society

The American Welding Society is organized to provide united and co-operative action in extending the knowledge of the art of welding and its field of industrial application. The field for further application of welding is enormous, and progress in it is being delayed only by incomplete knowledge and by the confusing and opposing claims of competing interests.

The Society acts as a clearing house for information. Through papers and monthly meetings of local sections of the Society an opportunity is created for the individual manufacturer, engineer, plant superintendent, foreman, operator, etc., to contribute his own knowledge in welding and at the same time receive the benefit of the combined knowledge and experience of all other members of the Society. Special publications in addition to the regular monthly proceedings are issued from time to time giving results of researches, standardization work and other information of value to the members.

CLASSES OF MEMBERSHIP
Extracts From By-Laws

ARTICLE I.

Section 1. Individuals having received the approval of a majority of the Membership Committee shall become members of this Society upon the payment of dues, except in the case of honorary members who shall be elected by unanimous vote of the full Board of Directors.

Section 2. Membership shall be divided into five classes:

Class A. Sustaining members, being individuals or individuals delegated by corporations, firms, partnerships, etc., interested in the science and art of welding, with full rights of membership.

Annual dues $100.00

Class B. Members, being individuals interested in the science and art of welding, with full rights of membership.

Engineers or individuals competent by experience or training to plan or direct welding operations are eligible to this class.

Annual dues $20.00

Class C. Associate members with right to vote but *not* to hold office, except in Sections as may be provided for by the By-Laws of the Sections. Supervising welders, inspectors and skilled operators, with three or more years' practical experience in welding are also eligible to this class.

Annual dues $10.00

Class D. Operating members, who are welders or cutters by occupation, without the right to vote or hold office except in Sections as may be provided for by the By-Laws of the Sections.

Annual dues $5.00

Write to the Secretary for a membership blank.

AMERICAN WELDING SOCIETY

ESTABLISHED 1919

JOURNAL

VOL. 1 MARCH, 1922 NO. 3

Annual Meeting American Welding Society

April 26th, 27th, 28th and 29th, 1922

ENGINEERING SOCIETIES BUILDING

33 West 39th Street, New York, N. Y.

ALL SESSIONS START PROMPTLY AS SCHEDULED

PROGRAM

WEDNESDAY, APRIL 26, 1922

MORNING SESSION

10 a. m. to 2 p. m. Pressure Vessel Welding **Room 2, Fifth Floor**

There is urgent need for cooperation among the tank manufacturers to carry out investigations which will enable the A. W. S., A. S. M. E. and other interested organizations to draw up a code for the welding of unfired pressure vessels which will have the proper requisites for safety without placing unjust restrictions on the use of welding in such construction. A conference has been called at which the tank manufacturers are to be present and a program outlined for handling the situation efficiently and economically. Further information and details are contained in the February and March issues of the Journal.

AFTERNOON SESSION

3 p. m. Welding Wire Specifications Committee. **C. A. McCune, Chairman**
10th Floor, A. I. E. E.

Extension of existing specifications and folios and plans for coming year.

3 p. m. Resistance Welding Committee. **Hermann Lemp, Chairman**
11th Floor, Council Room

Standardization of rating and nomenclature; summaries on butt, seam, spot and percussive welding; general recommendations for the most important research in resistance welding.

EVENING SESSION

7 p. m. Beefsteak Party

In order to provide an opportunity for an Informal Social Get Together Meeting, the Committee has arranged a Beefsteak Dinner at Reisenweber's, Fifty-eighth Street and Eighth Avenue, to which all members are invited. A good time is promised to everyone. Tickets may be obtained at the office of the Society at $6 each.

THURSDAY, APRIL 27, 1922

MORNING SESSION

10 a. m. Business Session of American Welding Society. Room 2, Fifth Floor

PROGRAM

1. President's Report on Year's Activities.
2. Reports from (a) Finance Committee.
   (b) Membership Committee.
3. Report on Publication.
4. Report from American Bureau of Welding and its Research Committees.
5. Report of Tellers' Committee on Election of Officers.
6. Introduction of new President.

AFTERNOON SESSION

2 p. m. Board of Directors, American Welding Society (including retiring and new members). 10th Floor, A. I. E. E.

PROGRAM

1. Review of progress during past year.
2. Introduction of new President.
3. Plans for coming year.
4. Appointment of Committees.
   (a) Executive.
   (b) Finance.
   (c) Membership.
   (d) Meetings and Papers.
   (e) Revision of By-Laws.

2 p. m. Committee on Specifications for Steel to be Welded. W. J. Beck, Chairman. 11th Floor, Council Room

Specifications for steel for tank work; joint plates for welded rail joints; rails and pipes.

EVENING SESSION

8 p. m. Technical Session of American Welding Society. Room 2, Fifth Floor

PROGRAM

Welding of Heavy Copper Plate. A. S. Kinsey.
Electric Welding of Dredge Pipes. J. H. Nead and R. L. Kenyon.
Thermit Welding. J. H. Deppeler.

FRIDAY, APRIL 28, 1922

MORNING SESSION

10 a. m. Electric-Arc Welding Committee. H. M. Hobart, Chairman 10th Floor, A. I. E. E.

Carbon Arc, Cast Iron Welding; Standardization Rules Electric Arc Welding Apparatus.

10 a. m. Gas Welding Committee. S. W. Miller, Chairman 11th Floor, Council Room

Cast Iron Welding; Welding of Pipes.

AFTERNOON SESSION

2 p. m. American Bureau of Welding 11th Floor, A. S. M. E.

PROGRAM

1. Progress Report.
2. Election of Officers.
3. Discussion of Policies.
4. Plans for Future Activities.

SATURDAY, APRIL 29, 1922
MORNING SESSION

10 a. m. Committee on Training of Operators. J. C. Wright, Chairman
10th Floor, A. I. E. E.

Progress in drawing up course for training of welding operators which will include qualifications for welders, selection of applicants for training, testing of welders, fundamentals of welding, analysis of welding jobs, bibliography.

10 a. m. Committee on Welding of Storage Tanks. J. C. Lincoln, Chairman
11th Floor, A. S. M. E.

Completion of report on two methods of welding tanks by electric-arc; also report on gas and resistance methods.

WELDING CONFERENCE COMMITTEE COMPLETES ITS REPORT

With the submission of their report at the Public Hearing of the Boiler Code Committee on Dec. 5, the Welding Conference Committee completed its work. This report served as the basis for the code which the Boiler Code Committee drew up and distributed at this meeting. Although this code does not meet with the entire approval of the Welding Industry, there are not, in the opinion of the Boiler Code Committee, sufficient data available to justify them in drawing a more lenient or complete code. Owing to the fact that the work assigned to this Committee has been accomplished, as far as possible, with the present means at our disposal, the Executive Committee of the American Bureau of Welding has voted to discharge the Welding Conference Committee and to extend its heartiest appreciation to the Chairman and members of the Committee for their excellent work.

This does not mean that there is no more work to be done in this field, but that further progress must depend upon the results of a comprehensive and thoroughly scientific research of the various problems involved. To this end the Bureau has endeavored to get the tank manufacturers to cooperate in this movement not only in contributing funds, but also by assisting, as far as possible, in the actual conduct of the experimental work. A meeting of the tank manufacturers for the purpose of completing its organization is to be held at the time of the annual meeting of the Society on Wednesday, April 26, at 10 a. m., in the Engineering Societies Building. A notice of this meeting, together with a suggested program of research, is given in this issue under research activities.

FIRST ANNUAL DINNER of AMERICAN WELDING SOCIETY

April 26

A beefsteak party will be a feature of this year's annual meeting of the American Welding Society.

This event, the first annual dinner to be held by the Society, will take place at Reisenweber's Fifty-eighth Street and Eighth Avenue, New York City, at seven o'clock, Wednesday evening, April 26. It will be solely a good-fellowship affair, with a lot of fun in between, a maximum of good things to eat, and a minimum of "speeches."

Every member of the A. W. S. is invited not only to attend this dinner himself, but to bring his friends as well. Out-of-town members attending the annual meeting should make a point of staying over for the party.

Tickets may be secured from the Secretary of the Society at six dollars per plate. Reservations should be in before April 12.

BUREAU OF STANDARDS ISSUES NEW BULLETIN ON WELDING AND CUTTING BLOW PIPES

Under date of Dec. 28, 1921, the Bureau of Standards issued Bulletin No. 200 covering an investigation of

oxy-acetylene welding and cutting blow pipes with especial reference to their design, safety and economy of operation. Copies may be obtained at 35c. each by writing to the Bureau of Standards. The contents of this report includes purpose and history of investigations, description of equipment used in testing the blow pipes, materials used in tests, secondary studies for securing data for interpreting tests, description of the tests and discussion of test results. The bulletin which consists of 108 pages, includes many photographs, tables and charts.

RESEARCH ACTIVITIES

LETTER SENT TO MANUFACTURERS OF UNFIRED PRESSURE VESSELS

Fusion Welding of Pressure Vessels

GENTLEMEN:

Under date of Feb 18, I sent a circular letter to some 200 tank manufacturers outlining the need for cooperation in conducting a program of research which would serve as a basis for a Code for the welding and testing of unfired pressure vessels which would not place unjust restrictions on the use of welding. A plan for conducting the work was also briefly outlined.

A number of replies, nearly all favorable, have been received. To bring matters to a head, we have scheduled a conference of manufacturers for Wednesday, April 26, from 10 a. m. to 2 p. m. This day was chosen because it precedes the annual meeting of the American Welding Society on Thursday. An agenda for the meeting is attached.

Several manufacturers have requested a list of those who have promised to cooperate in the program. An abstract of the replies received is attached as Appendix A. We realize that the number of replies received to date is relatively small, but the interest shown is sufficient to warrant the belief that many of those who have not yet replied will join the movement when they have heard the matter thoroughly discussed. To this end we have decided to call the meeting, and we sincerely urge the attendance of all who are at all concerned. No financial obligation will be incurred by such attendance.

In connection with the explosion of a small welded boiler used to furnish steam for clothes pressing, the following comment was printed in the March 14, 1922, issue of Power.

"It is the possibility of this kind of thing that has justified the conservative attitude of the Boiler Code Committee and of the governmental inspection bodies with regard to the use of welding in boiler and pressure-vessel construction. Much excellent work is being done. There are many applications where its use is particularly advantageous. Properly done, it is reasonably safe for many uses even under pressure; but as yet no practical means for determining whether a joint is properly made has been developed, short of a test to destruction."

It is interesting to note that several weeks later an account of another explosion appeared in this publication, in which seven lives were lost and twenty-one injured; but, inasmuch as welding was not used, no comment was made as to uncertainty of construction.

The above is cited merely as an illustration of the importance of the problem.

Unless we can secure adequate financial assistance, we believe it is useless for the Bureau to attempt anything further in the matter, in which case it will be up to the individual tank manufacturer to fight his own battles as best he may. In order to bring the financial side of the situation to a head, kindly be prepared to advise how to determine a basis for a just distribution of the annual expense (which is estimated at $50,000) among the interested tank manufacturers. For example, it has been suggested that $2.00 per gross $1,000 an-

nual business is an equitable share. Another suggestion is to determine the amount on a basis of tonnage.

In order to meet the needs during the period of organization, from three to six months, it is estimated that $600 per month will be needed. It would be helpful if you could state how much your company would be willing to donate for immediate use during the organization period. A budget can be drawn up by the Committee after a program is laid out. A tentative program for the conduct of research work is included as Appendix B.

Kindly indicate on the attached card whether or not you or your representative will attend the conference.

Yours very sincerely,

C. A. ADAMS,

Director, American Bureau of Welding.

Appendix A

EXTRACTS FROM REPLIES RECEIVED FROM TANK MANUFACTURERS

Littleford Brothers, Cincinnati, Ohio

We are in accord with the work your Committee is doing, and when the time comes we will contribute an amount which we feel justified.

Henry Vogt Machine Co., Louisville, Ky.

We are interested and request that you advise us the number of manufacturers that have expressed their willingness to contribute to the fund.

The Pfauldler Company, Rochester, N. Y.

We will be very glad to work with you and to offer the use of our Metallurgical Laboratory and assistance of our Metallurgist without charge and to assist financially in conjunction with all other interested parties. We believe that not only manufacturers of welded pressure vessels, but also all purveyors of equipment and supplies to such manufacturers should be solicited to cover the estimated necessary amount. We feel that it might be well to inform those interested by presenting a list of the firms approving and offering to subscribe. By doing this it may be that certain people who ought to be affiliated in the work can be brought into line.

The Elyria Enameled Products Company, Elyria, Ohio

We are vitally involved in this matter, and we can assure you that we will be very glad to join in the work in any way that conditions may warrant.

York Manufacturing Company, York, Pa.

This Company will do its part of the research work, and if a sufficient number of firms join in the plan so as to reduce our share to a reasonable amount, we will assist in financing it.

W. A. Case & Son Manufacturing Co., Norristown, Pa.

We with all our experience feel that there is still great room for improvement and research work. We still doubt if there has been as much research work done in all the years of riveted seams as has already been done for welded seams; yet they are accepted, based mainly on experience, which we think will also apply largely to the welded product. Nevertheless, we are in favor of research work as long as it is not carried to extreme, thus running the expenses unnecessarily high.

The Vilter Manufacturing Company, Milwaukee, Wis.

We have already made some tests under the supervision of Professors Larson and Roark of the University of Wisconsin. These have been submitted to the Boiler Code Committee. We are perfectly willing to cooperate with you in this matter in every way possible, but, in view of the expense which we have already incurred, we do not feel that we should be called upon to contribute to tests to be made, which would cover the ground which we believe we have adequately covered.

Fabricated Steel Products Corporation, Leetonia, Ohio

We shall be glad to cooperate with you and other manufacturers.

Detroit Range Boiler & Steel Barrel Co., Detroit, Mich.

We do a great deal of welding work here, and we are very much interested in any welding proposition and are ready to support any such movement.

The extent of that support would have to be determined as to the comprehensiveness of the plan. We can assure you we will be willing to do our share.

R. S. Newbold & Son Company, Norristown, Pa.

We believe that it would be greatly to the advantage of all manufacturers of welded steel plate work to support some central committee or bureau such as you suggest, so that the welding and testing of steel pressure vessels will be covered by some standardized code, as is the case with steam boilers. The information your Committee would obtain in conducting laboratory tests, such as you propose, would be of great benefit to the whole industry. We only use welding to a relatively small degree, but we will be glad to do what we can to cooperate with you in this work.

The Galigher Machinery Company, Salt Lake City

We are willing to cooperate with you to forward the art of welding in any way possible, and will contribute financially and otherwise to this end, provided that the cost is not too excessive to any one class of concerns engaged in welding. We have a large and well-equipped shop for both arc and oxy-acetylene welding, and this shop is at the disposal of your Committee for any work you may have in contemplation of an experimental nature; the work to be prosecuted either under our own direction or under the direction of any expert you may have for that purpose.

Appendix B.

WELDING OF UNFIRED PRESSURE VESSELS

Suggested Program of Research

I. Standardization of destructive methods of testing different kinds of pressure vessels.

II. Testing to destruction a large number of tanks made by different manufacturers under the several methods now used. The conditions of welding will be carefully noted by a representative of the Committee. The report of results will be published with distinguishing letter instead of name of manufacturer.

III. Testing of a number of tanks welded under conditions specified by the research committee after consideration of results obtained under Item II. Results obtained under Item II will undoubtedly show that certain methods are good others are bad. To settle these doubtful points and to enable the Committee to know definitely just what can be expected under certain conditions a number of tanks will have to be welded and tested in accordance with conditions specified by the research committee and under their control. By obtaining comparative figures from these tests, specifications will be drawn up governing construction of vessels.

IV. Standardization of non-destructive tests for pressure vessels. These rules will be based on results obtained under II. and III.

V. Drawing up of code.

AGENDA CONFERENCE TANK MANUFACTURERS WELDING UNFIRED PRESSURE VESSELS

April 26, 10 a. m. to 2 p. m.
Room 2, Fifth Floor, 33 West 39th Street, New York City

I. Purpose of Meeting; Need and Importance of Problem; Proposed Method of Handling It; Financial Statement. C. A. Adams

II. Probable Value of Undertaking; Similar Example in Malleable Casting Field. S. W. Miller

III. Cooperation and Attitude of Boiler Code Committee of American Society of Mechanical Engineers D. S. Jacobus

IV. Viewpoint of Insurance People. S. F. Jeter

V. Discussion.

VI. Organization
1. Appointment of Executive Committee
2. Appointment of Ways & Means Committee
3. Appointment of By-Laws Committee
4. Appointment of Research Committee

VII. Next Meeting.

SECTION NEWS

CHICAGO SECTION

The March meeting of the Chicago Section, held in the rooms of the Western Society of Engineers, Friday, March 3, was given over to a talk and discussion on the subject of "Commercial Applications of the Electric Arc," by Mr. A. M. Candy, of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

Mr. Candy brought with him numerous interesting slides illustrating a wide range of applications of the arc, this feature being particularly helpful since there was in attendance at the meeting the usual quota of students from local welding schools.

Following Mr. Candy's paper, a general discussion took place which brought out many interesting points. However, difference of opinion is an index to growth, and helpful to the cause of welding and the advancement of the art.

At a recent meeting of the Directors of the Chicago Section Mr. H. W. Kurtz, Secretary, Gas Products Association was elected a director to fill the vacancy of Mr. Don B. McCloud, whose business interests have taken him away from Chicago. At the same meeting Mr. Henry S. Mann, Metal & Thermit Corporation was elected Director to fill the vacancy of Mr. Andrew Oliver, who has left Chicago to assume a new position with the General Boilers Company, Waukegan, Ill.

The coming April meeting of the Chicago Section will be held in the rooms of the Western Society of Engineers, Monadnock Block, Dearborn & Van Buren Streets, Chicago, Friday evening, April 7, at 8.00 p. m. The subject will be an extensive moving picture on the general subject of "Oxy-Acetylene Welding" prepared under the supervision of the Bureau of Mines for the Air Reduction Sales Company, together with a lecture on this subject by Professor A. S. Kinsey.

Attendance at meetings of the Chicago Section has been most excellent during the past few months. Sixty-five enthusiasts were in attendance at the March meeting, many of whom traveled long distances. A cordial invitation is extended to all interested in welding to attend these meetings which are held the first Friday of each month in the room of the Western Society of Engineers.

TANK WELDING AND ARC WELDING APPARATUS FEATURED AT NEW YORK MEETING

Two excellent papers were presented at the February meeting of the Metropolitan Section. The first by A. L. Price of the Franklin Machine & Steam Boiler Works dealt with the welding of tanks by both the metallic and carbon arc process. Mr. Price, who is one of the pioneers in tank welding gave some valuable information on the subject and the discussion which followed brought out many methods both good and bad that are now being used in tank welding.

The characteristics of direct current machines from early design to present day types were presented by W. Siebenmorgen. Diagrams of internal electrical connection of the different machines on the market were shown. Mr. Siebenmorgen explained the evolution of the modern types of constant current, constant energy and constant potential arc welding machines and the advantages claimed for each type.

At the March meeting, held on the 21st, R. S. Donald of the Thomson Electric Welding Co. gave an interesting address describing the processes of Resistance Welding from its origin to the present time and illustrated his talk with a large variety of samples of various kinds of welds made by the resistance processes of practically all the metals which it is feasible to weld with this process at the present time. Mr. Donald satisfactorily answered the questions raised in the discussion at the February meeting as to the welding of high carbon and alloy steels to mild steel as well as the welding of non-ferrous metals. He also stated that it was now possible to weld cast iron to steel by the resistance method.

The majority of failures of resistance welding are due to the fact that people not thoroughly familiar with the subject attempt to make them without using the necessary precautions as regards cleanliness and freedom from rust and scale on the parts to be welded.

FEBRUARY MEETING, NORTHERN NEW YORK SECTION

A February meeting of the Northern New York Section was held on the 29th and was addressed by J. L. Anderson of the Davis-Bournonville Company on "Automatic Tube Welding Machinery." Mr. Anderson's paper is published in this issue of the Journal.

A research committee of this Section was organized under the chairmanship of R. E. Wagner. Activities were divided into two groups, namely welding of copper and its alloys and the welding of manganese steel. Sub-committees are working on each of these problems.

The March meeting will be held on the 28th and will be addressed by W. E. Ruder of the Research Laboratory of the General Electric Company on the subject of "Metallurgy in Welding."

PHILADELPHIA MEETING DEVOTED TO SHIPBUILDING

Two very excellent papers on Shipbuilding were read at the February meeting of the Philadelphia Section. H. J. Cox of Lloyd's Register of Shipping presented a paper on the progress made in Electric Welding in Japan, particularly in shipbuilding work. Mr. Cox has just returned from a trip abroad and gave first hand information of his interesting observations. Mr. Cox's paper will be published in an early issue of the Journal. The second paper dealt with the "Application of Electric Arc Welding to Two Vessels" by M. Haramiishi. Mr. Haramiishi's paper was published in the February issue of the Journal. Lantern slides illustrating the two papers were shown.

PITTSBURGH SECTION

The monthly meeting of the Pittsburgh Section was held on Feb. 24 in the Monongahela House, Water and Smithfield streets, Pittsburgh, Pa.

Mr. H. A. Stewart, Foreman Welder of the National Transit Pump and Machinery Co., Oil City, Pa., presented a paper on the subject of "Welding of Stellite," Electric, Gas and Brazing. This paper opened up a general discussion which was beneficial to all present.

REPORTS FROM SAN FRANCISCO

A meeting of the San Francisco Section of the American Welding Society was held at the Engineers Club on Feb. 19 with sixty-five members present. Progress has been made in laying out a program for the coming year and in drawing up by-laws for the Section. A very interesting paper with stereopticon slides was presented by A. V. Thompson of the General Electric Company on the "Reconditioning of Locomotive Boilers." An interesting discussion followed by those in attendance and particularly by the railroad men.

A suggestion was made that as many inspectors as possible be urged to come to Welding Society meetings and thereby increase their knowledge concerning the art.

NEW MEMBERS FOR MONTHS OF JANUARY, FEBRUARY AND MARCH

	Class
CHICAGO	
F. L. ReQua, Welder, 4918 Glenwood Avenue	D
F. B. Toombs, Sales Engineer, Chicago Steel & Wire Co.	C
E. T. Weart, Welder, 4524 North Hermitage Avenue	D
CLEVELAND	
Louis Barrett, Welder, Standard Welding Co.	D
G. E. Doan, Chief Metallurgist, Rail Welding & Bonding Co.	B
Valdemar Hansen, Welder, Cleveland Tractor Co.	C
Wm. Morris, Welding Supervisor, Standard Welding Co.	D
Emerson P. Poste, Director of Laboratories, The Elyria Enameled Products Co.	C
M. Teter, Ohio Chemical & Mfg. Co.	C
NEW YORK	
Konrad Braun, Machinist, Delaware, Lackawanna & Western Railroad	D
Charles Burton, Machinist, Delaware, Lackawanna & Western Railroad	D
Edward J. Doyle, Plumber Foreman, Delaware, Lackawanna & Western Railroad	D
M. R. Feeley, General Foreman, Delaware, Lackawanna & Western Railroad	D
George Fowler, General Foreman, Delaware, Lackawanna & Western Railroad	D
Chester F. Gailor, Consulting Engineer, Rail Welding & Bonding Company	A
William Grant, Machinist, Delaware, Lackawanna & Western Railroad	D
Frank Henderson, Round House Foreman, Delaware, Lackawanna & Western Railroad	D
Otto Kraft, Foreman, Delaware, Lackawanna & Western Railroad	D
Joseph A. Kron, Round House Foreman, Delaware, Lackawanna & Western Railroad	D
T. Lynch, Welder, Delaware, Lackawanna & Western Railroad	D
S. J. McNamara, Welder, Delaware, Lackawanna & Western Railroad	D
Otto Mardos, Electric Welder, 1720 First Avenue	D
E. L. Mathews, Way Superintendent, Third Avenue Railway Co.	B
Charles E. May, Round House Foreman, Delaware, Lackawanna & Western Railroad	D
Henry Murray, Welder, Delaware, Lackawanna & Western Railroad	D
Albert Phillips, Electric & Acetylene Welder, East 44th Street	D
John Wm. Sleight, Machinist Foreman, Delaware, Lackawanna & Western Railroad	D
George J. Smith, Foreman, Delaware, Lackawanna & Western Railroad	D
Raymond Speer, Machinist, Delaware, Lackawanna & Western Railroad	D
John F. Trudel, Dept. Foreman, Delaware, Lackawanna & Western Railroad	D
Jas. M. Williams, Round House Foreman, Delaware, & Lackawanna & Western Railroad	D
Ralph F. Wolfe, Machinist, Delaware, Lackawanna & Western Railroad	D
NORTHERN NEW YORK	
F. H. Baker, Treasurer, Baker Manufacturing Corp.	B
J. W. Belanger, Commercial Engineer, General Electric Co.	C
D. H. Deyoe, Electrical Engineer, General Electric Co.	C
J. C. Hoar, Engineer of Machinery, American Locomotive Co.	C
W. L. Lown, Electric Welder, 145 River Street	D
R. H. White, Engineer of Construction, American Locomotive Co.	C
H. A. Winne, Electrical Engineer, General Electric Co.	C
PHILADELPHIA	
James H. Gravell, Consulting Engineer	B

	Class
Geo. C. Hays, Electric Welder, White Clay Mine Co.	D
Jos. S. Oechsle, Oechsle Brothers	B
PITTSBURGH	
T. R. Johnson, Garage Manager, Johnson Garage	D
V. H. Miessner, Pittsburgh Malleable Iron Co.	B
SAN FRANCISCO	
L. B. Ard, Sales Engineer, Chase Metal Works	D
C. A. Benson, Welder, California Steel Products Co.	D
K. L. Brackett, Pacific Coast Manager, Air Reduction Co.	B
H. F. Brown, Proprietor, Brown Bros. Welding Co.	B
J. C. Clark, Associate Professor, Elec. Engng. Stanford University	C
Patrick Coyne, Manager, Stuart Oxygen Co.	B
G. A. Gehlert, Service Engineer, Davis Bournonville Co.	B
J. G. Gossman, Application Engineer, Oxweld Acetylene Co.	B
Mark Haines, Proprietor, Welding Shop	C
W. B. Sawyer, Jr., U. S. Steel Products Co.	C
W. H. Seaver, Manager of Sales, U. S. Steel Products Co.	C
H. O. Stevens, President, American Rolling Mill Co. of California	B
D. J. Williams, Asst. Pacific Coast Mgr., Air Reduction Co.	B
J. S. Wilson, Asst. Mgr., American Rolling Mill Co. of California	B
H. L. Wintersgill, Commercial Engineer, Westinghouse Elec. & Mfg. Co.	C
R. A. Wood, Western Pipe & Steel Co.	A
SOCIETY (not in sections)	
R. Hennessy, Acetylene Welder, 929 East 11th St., Seattle	D
E. H. Kendall, Engineer, Erie Forge Co.	B
H. D. Lloyd, General Manager, The Whitecross Co., Ltd., England	B
A. O. Nordine, Commercial Welder, 301 Horton St., Seattle	D
Arthur Stephenson, Chief Engineer, Allen Liversidge Ltd., England	B
L. J. Smith, Asst. Engr., Pacific Electric Railway Co., Los Angeles	B
S. M. Swanson, Welder, 3207 First Avenue, Seattle	D

EMPLOYERS ATTENTION

WE HAVE IN OUR FILES THE RECORDS OF MEMBERS WHO HAVE HAD FROM ONE TO FIFTEEN YEARS' EXPERIENCE IN THE WELDING FIELD. IF YOU NEED ANY WELDING TALENT, KINDLY LET US KNOW. THIS SERVICE IS FREE.

SERVICES AVAILABLE

A-5—Electric Welder desires position. Have had twelve years' experience and am willing to go any place in or out of the States. Am capable of handling big jobs. Also can act as Instructor or Supervisor. Do a little acetylene welding and cutting, and was connected with the Lincoln Electric Co. until business depression.

A-6—Welder, age 31, married, desires position. Three years' experience in marine boiler repairs, tanks, cast iron, brass, manganese, etc., with electric arc. Have also a fair working knowledge of acetylene welding. Have been employed for past two and half years with Staten Island Shipbuilding Co.

A-7—Expert welder desires position. Can handle oxy-acetylene, electric or thermit welding. Have welded castings weighing as high as 6300 lbs. Have studied welding from a chemical standpoint as well as practical. Can discuss all questions of work and most equipment. Have digested most everything I could get on welding.

BOILER WELDING*

By Edward H. Heidel

Boiler Foreman, C. M. & St. P. R. R.

Boiler welding requires perfect fusion of metals and the absolute control of the flame or electrode, as the case may be. Experiments or guess work must be eliminated and welds made only according to latest approved methods. Only experienced welders should be allowed to make welds in fire boxes or any pressure work.

The time necessary for an operator to qualify as a boiler welder depends entirely upon the individual himself. At the start a test weld should be made at least once a week for breaking or bending test; inspection of break will show development made as well as the defects yet to be overcome. When these test pieces show operator has become proficient a test piece of standard dimensions should be submitted to the engineer of tests for final analysis and approval. If this sample test piece meets all the necessary requirements, the operator may be permitted to weld on fire box or other pressure repair work.

Welding rod material for boiler work must at all times conform to specfications for gas and electric welding rods, and none other should be used. Welding wire specifications of the American Welding Society for mild steel has proven to give the best results.

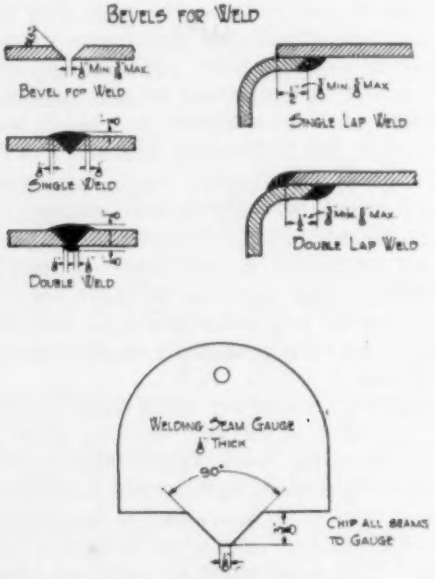
No piece of work that is to be welded is properly prepared unless it is thoroughly cleaned and free from al' scale, oil, rust, or other foreign substance. The weld must be made on clean, bright metal at all times and that condition must be maintained throughout the welding operation. Places not chipped clean in beveling or coated with oil should be cleaned with a roughing tool or sand blasted; also the metal should be cleaned at least $\frac{1}{4}$" on each side of the bevel.

Carefully fit all patches, cracks or sheets allowing no more than 3/16" or less than $\frac{1}{8}$" space at the bottom of the "V" opening. When the opening is greater than 3/16" necessarily more metal will have to be added thereby slowing up the work and allowing for greater expansion and contraction. When the opening between the plates closes to less than $\frac{1}{8}$", welding must be stopped as the gas welding rod or electrode cannot properly penetrate to the bottom of the "V." When enlarging this opening use a hammer and chisel but where a cutting torch is used a slag or layer of oxide is left on the parts cut and unless removed, will become part of the weld, which will sooner or later show up as a defective weld.

All edges to be welded must be beveled to 45°, total 90°, except on very heavy material, one inch or over. All welders and those preparing seams for welding must be provided with a gage for testing the bevel and opening between the plates.

*Address before the February meeting of the American Welding Society, Chicago Section.

Reinforce all welds about 20% thickness of sheet which is in fire box work approximately 1/8". Where possible build up slightly from the opposite sides. Butt welding on longitudinal or cross seams, "lap" welding on flanges, sheets to be lapped 1/2", 5/8" maximum, 3/8" minimum.



Preparation and Design of Weld—Electric or Gas.

All sheets and patches must be cut on a standard or uniform line avoiding stay bolt holes where possible. Better results will be obtained where line of weld is located in center between stay bolt rows.

When cutting out sheet or patch which has previously been welded, all of the old weld must be thoroughly chipped out. It is good practice to extend patch or sheet one row of stay bolts larger or higher.

Where allowance cannot be made for expansion or contraction due to the design or shape of part to be welded, the "back step" method of welding is preferred.

In bolting up patches or sheets preparatory to welding, it is good practice to put in a 5/8" bolt through every fifth stay bolt hole and then from the opposite side screw in staybolt between each 5/8" bolt. This will hold the sheets in line, but should the sheet warp or buckle it would only be necessary to tighten up bolt on stay bolt to again line up the sheet.

Where sheets are to be welded in fire box by the gas process it

is necessary to remove the adjacent row of stay bolts as the holes will be pulled out of round and bolts cannot be tightened by hammering; however, this is not necessary when making weld using the electric process.

Certain restrictions have been placed on locomotive boiler welding known as the A. R. A. restrictions, which are as follows:

Locomotives—Autogenous Welding:

Rule No. 1: Autogenous welding will not be permitted on any part of a locomotive boiler that is wholly in tension under working conditions; this to include arch or water bar tubes.

Rule No. 2: Staybolt or crown stay heads must not be built up or welded to sheet.

Rule No. 3 Holes larger than 1½" in diameter when entirely closed by autogenous welding must have the welding properly stayed.

Rule No. 4: In new construction, welded seams in crown sheets will not be used where full size sheets are obtainable. This is not intended to prevent welding crown sheets to other firebox sheets. Side sheet seams shall not be less than 15 in. below highest point of crown.

Rule No. 5: Only operators known to be competent will be assigned to firebox welding.

Rule No. 6: Where autogenous welding is done, the parts to be welded must be thoroughly cleaned and kept cleaned during the progress of work.

Rule No. 7: When repairing fire boxes, a number of small adjacent patches will not be applied, but the defective part of sheet will be cut out and repaired with one patch.

Rule No. 8: The autogenous welding of defective main air reservoirs is not permitted.

Rule No. 9: Welding rods must conform to the specifications issued by the Inspection and Test Section, for the various kinds of work for which they are prescribed.

Standard practice in railroad work for firebox welding includes the following:

Welding of fire boxes complete.
Welding one-half and full side sheets.
Three-fourth door sheets.
Door collars.
Front and back flue sheet patches.
Stoker tubes.
Application of crown sheet.
Reinforcing mud ring corners and seams.
Welding flue sheets.
Welding flexible sleeves.
Welding broken mud ring.
Cut off and cut out stay bolts.

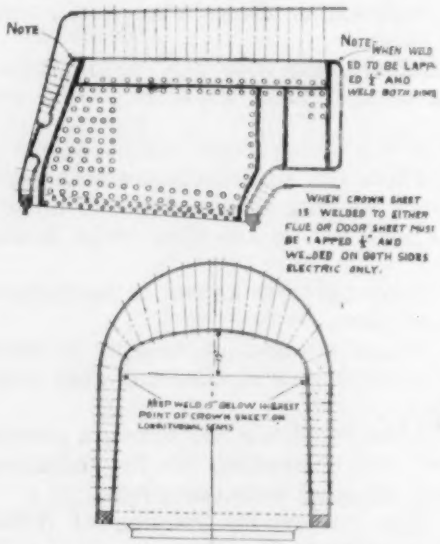
WELDING FIREBOX COMPLETE

Electric or Gas

The firebox should be set up, preferably in mud ring, with all staybolt and mud ring rivet holes put in, except mud ring corner holes, which should be drilled after sheet is laid up and welded.

Welding edge should be chipped to a 45-deg. angle (total 90 deg.) and chipped on a straight line so as to insure a uniform opening between welding edges of 1/8 in.

Lower portion of sheet from a point about 14 in. from bottom


NOTE
NOTE WHEN WELDED TO BE LAPPED ½" AND WELD BOTH SIDES
WHEN CROWN SHEET IS WELDED TO EITHER FLUE OR DOOR SHEET MUST BE LAPPED ½" AND WELDED ON BOTH SIDES ELECTRIC ONLY.
MEP WELD 15" BELOW HIGHEST POINT OF CROWN SHEET ON LONGITUDINAL SEAMS

Welded Fire Box, Combination Chamber Type.

of flue and door sheet should not be chipped until box is in place and mud ring corner laid up to ring.

Bolt sheets securely in place, being sure that there is a uniform opening of 1/8 in. all along welding edge. All fitting up to be done before welding is started. Hold sheets in place with strongbacks or clamps bolted through staybolt holes spaced about 12 in. apart. Tack sheets between clamps with a tack at least 3 in. long, when clamp can be removed and welding completed.

Lap welding of flanges on door sheet, throat sheet and flue sheet (sheets lapped 1/2 in.) is recommended when sheets are fit up in firebox, but when firebox is fitted up on the floor and can be welded from both sides, butt welding is preferred, except on crown sheet.

Welded crown sheet seam must be lower than 15 in. from the highest part of crown in all cases. Where crown sheet is welded to flue sheet and door sheet, sheets must be lapped 1/2 in. and welded on both fire and water side down at least 15 in.

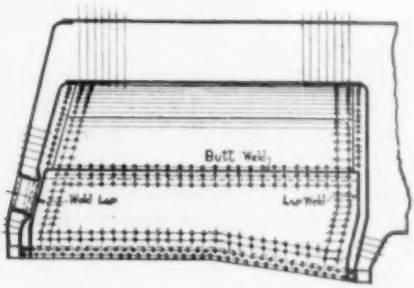
In complete firebox installation all mud ring rivets should be removed.

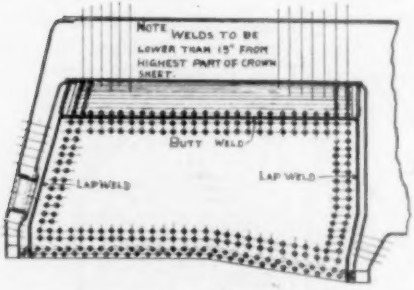
Use "back step" method starting at bottom of each intermediate space, welding upwards, finishing at top of seam.

FULL AND HALF SIDE SHEETS

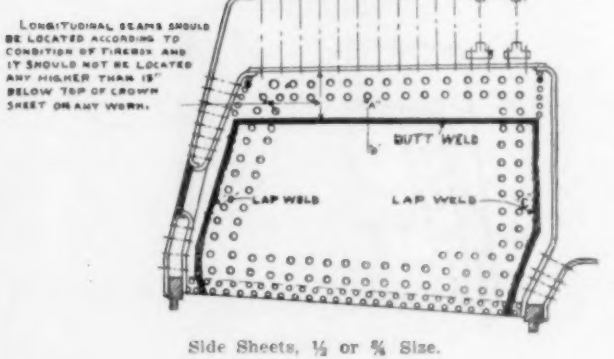
Electric or Gas

In applying side sheets, the sheet may be cut above mud ring between rivets and first row of staybolts, if rivets and sheet are in good condition, otherwise the sheet should extend to the bottom of the ring. The condition of the sheet will determine the location of

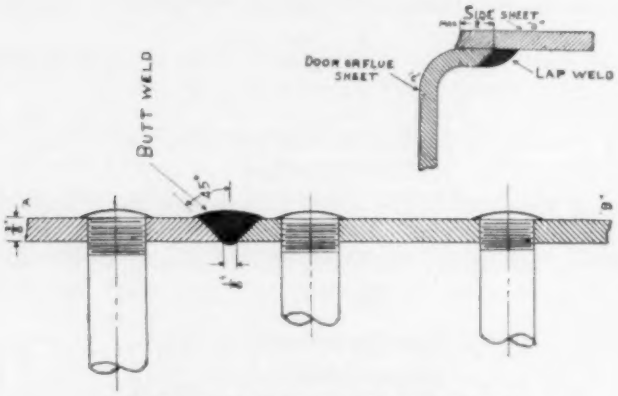




(Above) Half Side Sheet Weld.
(Below) Full Side Sheet Weld.


LONGITUDINAL SEAMS SHOULD BE LOCATED ACCORDING TO CONDITION OF FIREBOX AND IT SHOULD NOT BE LOCATED ANY HIGHER THAN 15" BELOW TOP OF CROWN SHEET OR ANY WORSE.
BUTT WELD
LAP WELD
LAP WELD

Side Sheets, ½ or ¾ Size.

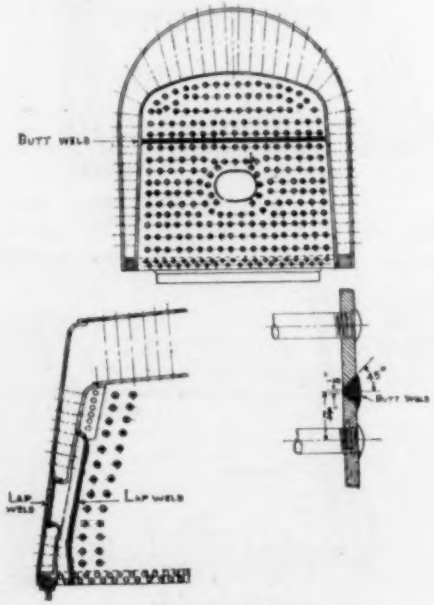


Side Sheets, ½ or ¾ Size. Details of Weld.

the top weld, but this top weld must be at least 15 in. below top of crown sheet.

In fitting new sheet in place standard bevel gage with the ⅛-in. opening must be used, sheet to be bolted in place to mud ring. Staybolts may all be applied except the rows adjacent to seam which is to be welded.

Tack sheet with a 3-in. tack every 12 in., then weld, using the back step method, alternating from center to either end. Welding on flanges must be done from the bottom up. Butt welding on cross seam and lap welding on flanges.



Door Sheet Weld.

THREE- QUARTER DOOR SHEET

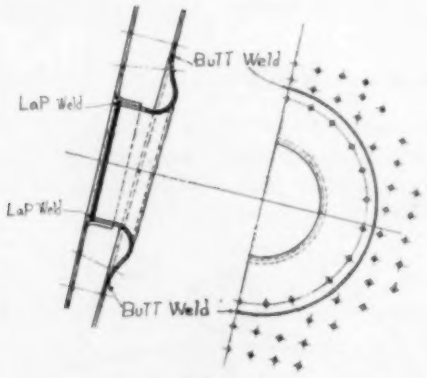
Electric or Gas

When three-quarter door sheets are applied, cut is made one, two or three staybolt rows above the door hole; condition of sheet determining location of cut. Bevel made from fire side, clamped and tacked every 12 in., using the back step method alternating from center to either end. Butt weld only.

DOOR COLLARS (O'CONNOR AND STRAIGHT)

Electric or Gas

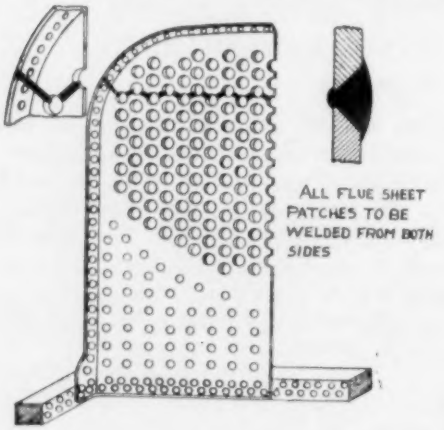
Where door collars are applied, line of cut will depend on the condition of the sheet, but in all cases door collars must have at least one full row of staybolts. Avoid locating line of weld through staybolt hole. After fitting up the sheet with gage, tack every 12 in. and weld, alternate from side to side to divide the strain. Butt weld in firebox and lap weld in door hole. Lap in door hole must be laid up tight to back head for at least 3 in. Sheet in door hole not laid up properly is the cause of leaky door holes whether welded or riveted.



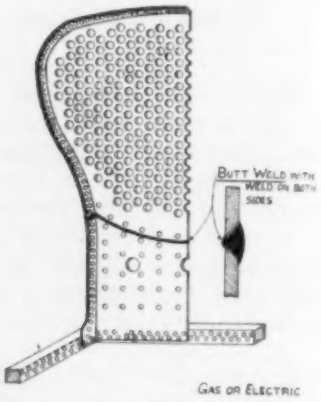
Door Collar—O'Connor Type.

FLUE SHEET PATCHES AND BRIDGES
Electric or Gas

Patches on flue sheet may be welded, line of weld depending on condition of sheets. In patching through flue holes cut should be made square with bridge instead of straight across, also the cut through flange to be on a 45-deg. angle instead of straight through. Patches are fit up with all flue holes in, with standard bevel and

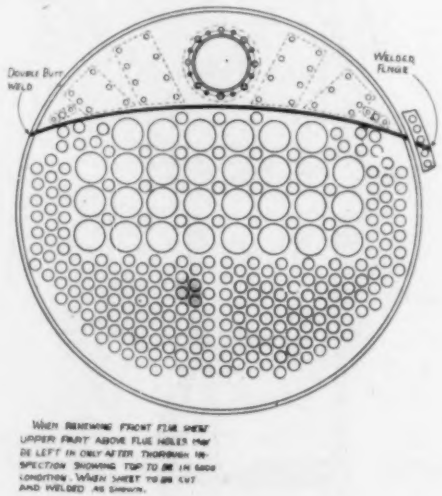


Flue Sheet Patch—Gas Preferred.



Flue Sheet Weld.

opening, clamped every 8 in. Then weld center bridge first, then bridge on each side, and continue changing until welding has been completed, welding flanges last. Welding to be done on fire side and in all cases reinforced on water side.

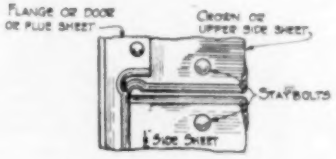

DOUBLE BUTT
WELD
WELDED
FLANGE
WHEN RENEWING FRONT FLUE SHEET
UPPER PART ABOVE FLUE HOLES MAY
BE LEFT IN ONLY AFTER THOROUGH IN-
SPECTION SHOWING TOP TO BE IN GOOD
CONDITION. WHEN SHEET TO BE CUT
AND WELDED AS SHOWN.

Front Flue Sheet.

Knuckle cracks in flue sheets not to be welded, when these occur apply new sheet.

Top or bottom half of back flue sheet may be renewed, care to be taken to see that line of weld clears all braces and does not fall through arch tube holes.

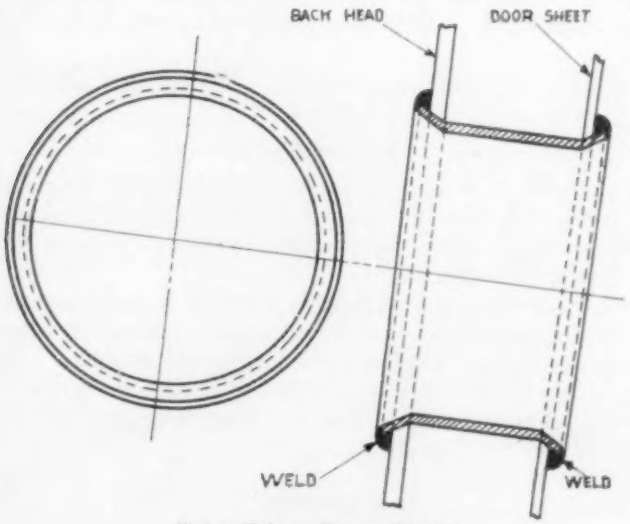
Cracked flue sheet bridges may be welded after the flues have been removed from that area by having the cracked bridges properly "V'd" out and welded. Allow the sheets to become cold after welding each bridge before starting another. Weld on both sides. Gas preferred.



STOKER TUBES

Electric or Gas

Where stoker tubes are to be applied, sheet is first marked off and cut on a 45-deg. bevel with gas cutting torch. Tube then set in allowing ⅜ in. on each end to be belled out. Tubes are then tacked in four places and welded from the bottom up, on both inside and outside.

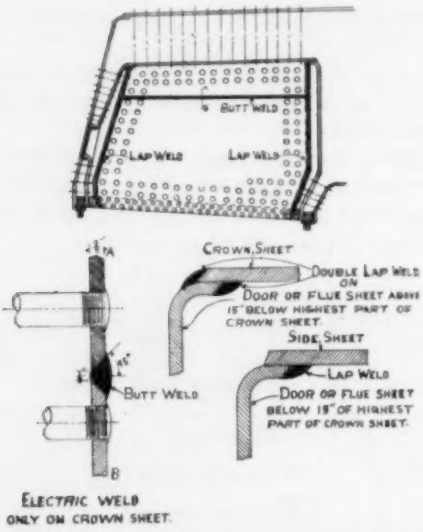


Stoker Tubes—Gas or Electric.

APPLICATION OF CROWN SHEETS

Electric or Gas

Application of crown sheets should be considered new construction and sheet so designed that line of weld will be lower than 15


BUTT WELD
LAP WELD
LAP WELD
CROWN SHEET
DOUBLE LAP WELD ON DOOR OR FLUE SHEET ABOVE IS BELOW HIGHEST PART OF CROWN SHEET.
SIDE SHEET
LAP WELD
DOOR OR FLUE SHEET BELOW 15" OF HIGHEST PART OF CROWN SHEET.
BUTT WELD
ELECTRIC WELD ONLY ON CROWN SHEET.

Welded Crown Sheets—Gas or Electric.

in. below top of crown sheet. When crown sheet is welded to door of flue sheet it must be lapped ½ in. and welded on both fire and water side. Carefully fit all sides using standard gage, tack every 12 in. when clamps should be removed and welding completed between tacks. Where possible reinforce from both sides.

REINFORCING MUD RING CORNERS AND SEAMS AT CAULKING EDGE

Electric Only

It is considered a good practice to reinforce mud ring corners inside and out as engines go through shop for classified repairs. Before welding, sheet should be chipped clean and free from oil, dirt or other foreign substance.

Corners should be caulked before welding is commenced. Metal applied should extend at least 6 in. beyond corner of ring and up about 8 in. inside and outside according to conditions.

Seams in the firebox can be reinforced in the same manner, first cleaning and caulking seam, then building reinforcement to height and width of sheet welded upon.

PATCHES

Electric or Gas

Patches may be applied to all sheets in the fire box with the exception of crown sheets. In applying patches to back flue sheet, line of weld must be lower than 15 in. from highest part of crown. Not more than two patches to be applied to any one sheet. When

further repairs are necessary, entire new section to be applied, large enough to eliminate the two old patches.

Crack in side or door sheet over three staybolts should not be welded, but a patch applied.

Avoid vertical welds in side sheets except at flanges.

Fit patch using standard gage, tack every 12 in. Start welding at the bottom, working up one side half way, returning to the bottom, working up opposite side to center.

It is good practice to apply patches in side sheets with a circular or elliptical shape, with a DISH pressed in about ¾ in. Patch held in place with machine bolt through every fifth hole, staybolts butted against patch and bolts placed in center of patch with nuts on the side of the welder, with which patch is to be straightened as welding progresses. Staybolts butted up against patch from the outside must be turned back or loosened as soon as welding reaches that point in order to remove stresses when weld is contracting.

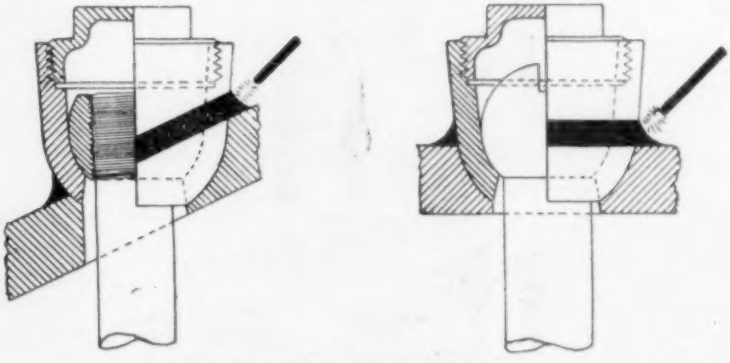
Half sheets are recommended instead of patches when making general repairs.

When repairing fire boxes, a number of small adjacent patches will not be applied, but the defective part of sheet should be cut out and repaired with one patch. This refers particularly to round house and running repair work.

WELDING FLEXIBLE SLEEVES

Electric Only

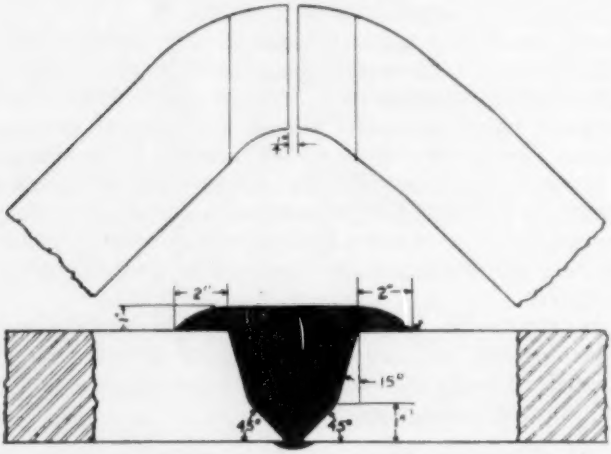
Holes are first cut or drilled in outside sheet, the size depending on type of sleeve used, 1 in., 1⅛ in., 2 in., 2⅜ in. Holes are then counterbored approximately 3/16 in. wide at seat to insure proper alignment of sleeve with bolt. It is good practice to bolt motor in place when counterboring at a greater angle than 10 deg. Do not use oil or lubricant of any kind as this will interfere with making a good weld. Before beginning welding of sleeve, sheet should be cleaned of scale, oil or other foreign substances; sand blast prefer-



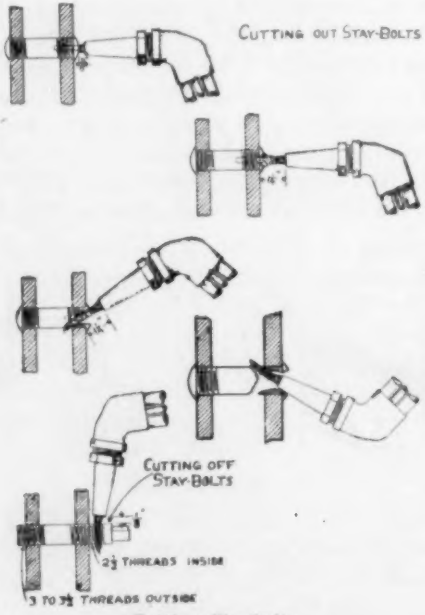
Welded Flexible Sleeve—Electric Only.

able. Line up sleeve with bolt end with special tool made for this purpose, which also holds sleeve to seat while welding.

In welding sleeve to sheet which consists of forming a light bond of metal or bead at point of angle as a seal, only sufficient metal to prevent leakage should be applied as the strength and security of the bolt does not depend upon the weld. Care should be taken at



Welding Broken Mud Ring. In Fusing in the Weld, Care Must Be Taken to Avoid Fusing the Metal to the Outer Plate.



Cutting Staybolts.

the beginning and ending of bead to avoid pin hole, which can be overcome by lapping weld.

BROKEN MUD RING

Electric or Gas

When the mud ring is broken, sheet in fire box should be cut between first and second row of staybolts and wide enough to work welding torch or electrode. Should there be any question as to the depth of length of crack, ring can be heated up dark red and allowed to cool when crack will show up very distinctly. Bevel the ring about 45 deg. leaving 3/16-in. opening at bottom. The weld should be reinforced about 1 in. on top and bottom.

CUTTING STAYBOLTS

Gas Only

The removal of scattered staybolts from engines and full sets in back shop with the cutting torch is recommended as good practice. Direct the flame of the cutting torch at the edge of the tell tale hole until the metal is heated. Then apply cutting jet of oxygen gradually at the same time moving the torch back and rotate so that at a distance of 1¼ in. the full pressure of the cutting jet is used.

After a depth of approximately ½ in. is reached the flame should be directed at a 45-deg. angle to the bolt until flame pierces through the bolt, then rotate until bolt is completely cut all the way around.

In cutting off staybolts, head of torch is held against sheet; care to be taken to see that cut is made straight and about 3 threads.

Get Your

Tickets for the

Annual Dinner

Bring Your Friends

AUTOMATIC SEAM WELDING AND THE MANUFACTURE OF TUBES

J. L. Anderson

The success of an automatic operation of whatever nature, requires the utmost care in the construction of the mechanism, the preparation of the work, and the uniformity of the motion required.

Automatic welding is no exception, and, in fact, requires even more care because the welding operation is autogenous (self-produced) and is the result of a combination of temperature, exterior pneumatic force, speed and mechanical pressure; a variation in degree of any one of these may be fatal to the success of the operation.

In order to be assured of final success, it is essential that material must be provided which is of suitable composition, reasonably accurate in thickness, and within much closer limits as to width in addition to having absolutely square edges.

Some manufacturers use only strip stock in coils, others use in addition considerable sheet stock, while a few use sheets entirely. The advantage in using sheet stock being the ability to produce tubes of any usual diameter promptly by slitting the sheets in a Gang Slitter. There is, however, more waste in meeting the requirements as to the length of tubes.

When preparing to manufacture welded tubing of any size or nature, consideration must be given to the purpose for which the tube will be used, the finish required and the temper or hardness desired or permissible, and from this point work backward to arrive at the proper width of strip and the gauge necessary to meet these requirements, the characteristics of the steel being known. In explanation, we will assume that a tube is required which must be accurate as to internal and external diameter; to meet this requirement it must be cold drawn with triblet inside. When drawing is required, it is customary to produce a tube approximately 1/32 in. over finished size, and in order to make a tube hold its shape when rolled it is necessary to have a strip of metal which is from 1/32 in. to 1/16 in. wider than actually necessary to form a circle of the required size, this excess metal is apparently lost in the compression of the tube while being formed, resulting usually in a slight increase in length of tube over that of the flat strip.

From these remarks it will be readily understood that it is essential to be prepared with a fullness of spacers for the Slitting Machine and rolls for the Tube Forming Mills, with variations in size to meet any requirement as to the finished tube.

The Gang Slitter is of the usual type, with the exception that the

*Presented before February, 1922, Meeting of Northern New York Section, A. W. S.

cutter shafts are of heavy alloy steel, with keys fitted the entire working length, with gearing arranged so that simultaneous adjustment of the bearings is provided, thereby maintaining accurate alignment and making possible the adjustment of the over-lap of the cutters to suit various thicknesses of metal. On these shafts are placed forged cutters ground to extreme accuracy and of such form that resharpening is done by grinding the face, thereby maintaining the original accuracy throughout the life of the cutter. Between the cutters are placed spacers alternating with a wide and narrow spacer on each shaft in order to bring the cutters in such position that the cutting action is identical on each edge of the metal, thereby preventing curling of the strip. When the spacers and cutters are all assembled on the shaft in sufficient number to cut the entire sheet, they are then locked by the adjusting nuts at the extreme end of the shaft.

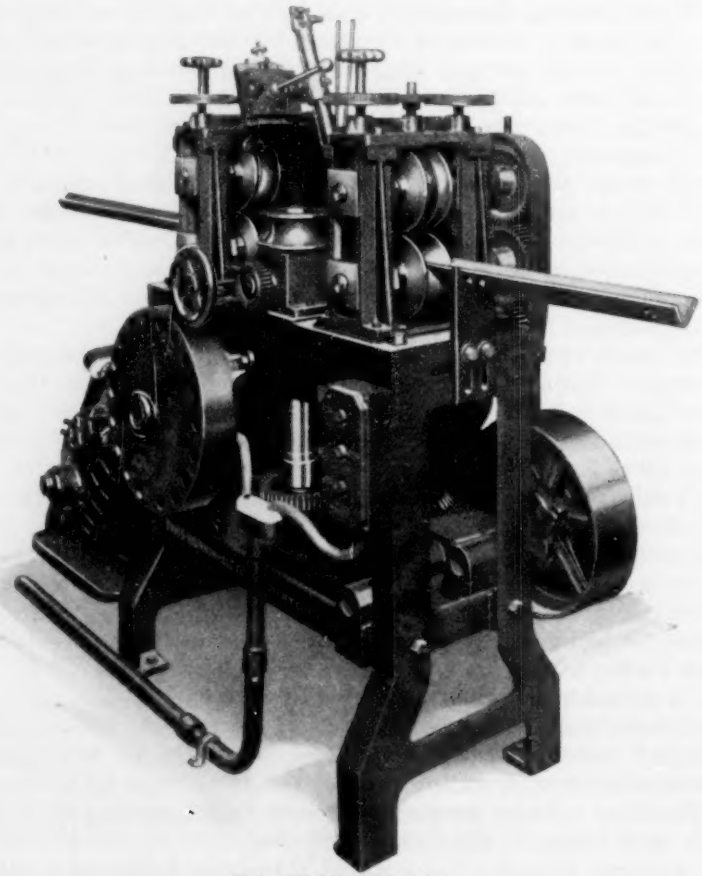
A unique feature in connection with the slitting of sheets is the finger arrangement, which prevents the strips while being cut from wedging between the cutters and are adjustable so that all tendency to twist or curl is eliminated. In order to make possible the changing of cutters and spacers, the end housing is arranged to withdraw and swing on a table provided for this purpose. For supporting the strips and sheets there is provided at each end a table which is usually of a length approximately that of the longest sheets which are to be cut. On the feeding table guides are provided which position the sheet in relation to the cutters so that there is always a trimming taken off each edge in order to produce equal conditions on all strips. The machine most commonly used cuts an entire 36″ wide sheet into strips at one pass, the speed being about 50 lineal feet of sheet per minute.

The most popular type of Forming Mill for the production of open seam tubing is of the two-stand type, comprising one set of break-down rolls, conductors for guiding the tube from the break-down rolls to the finishing rolls. In order to properly position a strip, there is provided an adjustable guide in advance of the break-down rolls which when set up in perfect alignment with the center line of the rolls guides the strip through the break-down rolls so that both edges are brought to the same degree of curvature, after which the strip enters the conductor, being propelled through the conductor by the break-down rolls, and while passing through the conductor being changed gradually in form from a section of a large diameter circle to that of an imperfectly formed "U" of the size approaching that of the finished tube; the real object of the break-down rolls being to produce a form of strip which will have sufficient rigidity to withstand the resistance to the deforming operation without buckling, and at the same time be presented to the finishing rolls in proper position for compressing to a perfect circle with edges in close abutment.

If you can visualize the gradual formation taken by a flat strip

approximately 30" long in changing from a flat section to a circle, you will realize what takes place in the formation of a tube in the Tube Forming Mill. The natural tendency in the formation of a tube from a flat strip is to curve downward, the seam being on top, due to the stretching of the edges, which is unavoidable, and must be counteracted while the strip is passing through the machine. This is accomplished by the adjustment of the conductor in relation to the center of the finishing rolls, the operation being that of depressing the nozzle of the conductor below the center line of the rolls in order to produce a compressing action on the edges of the strip. This action occurs previous to the final formation of the tube in the finishing rolls, and therefore corrects stretching and allows the tube to leave the machine perfectly straight.

There is another difficulty which must be corrected, and that is the unequal stretching of the edges causing the seam of a tube to wind. This tendency is corrected by two methods; one is the ad-



Tube Welding Machine

justment of the guide previous to the strip entering the break-down rolls; the other is the adjustment of the conductor, latterly, or sometimes a combination of both adjustments.

When it is desired to use strip stock in coils, a support for the coil is provided and a swinging cut-off saw is mounted on the delivery end of the machine. This is used in conjunction with an automatic stop which makes possible the production of formed tubes cut to length. The automatic stop is actuated by the tube when it has reached a certain length; this stop throws out the clutch and at the same time causes a braking action, stopping the mill instantly. At this time the operator moves the motor driven swing saw by hand, thereby severing the tube. The variation in length will seldom exceed $\frac{1}{2}$" by this method. The maximum hourly production of a machine forming and cutting tubes to length will seldom exceed 2000 feet, whereas with the use of strips previously cut to length the machine runs continuously without stopping, and will usually average 3000 feet per hour.

It is of the utmost importance that the roll and tube equipment of the Forming Mill be extremely accurate, and the machine adjusted to produce accurately formed straight tubing without twist, in order to make possible automatic operation of the Tube Welding Machines.

The Tube Welding Machine is in reality a mechanism for propelling an open seam tube at relatively slow speed by means of accurately machined rolls driven through reduction gearing. This reduction minimizes the slight fluctuations in speed of the driving mechanism due to various causes, and makes possible the maintenance of a puddle of molten metal of considerable area, extending entirely through the thickness of the metal at the desired point.

There is another function of the machine not usually apparent, which is the compression of the fused metal after solidifying. It is this compression, or working of the heated metal, which assists in the production of the exceptionally strong ductile welds produced by mechanical welding.

Still another feature of the machine is the mechanical means of counteracting the contraction strains set up by the welding and compressing operation, combined with the rounding and sizing of the tube as it leaves the machine. This is accomplished by an adjustment of the rolls in relation to each other so as to cause a bending action on the tube while hot.

In order to be assured of perfect tubing, the roll equipment must be very accurate, and it is by no means uncommon to produce tubes on the welding machine within a variation of .005 from size and roundness. Strange as it may sound, accuracy of this degree is practiced mainly on the cheaper grades of tubing, and for the purpose of eliminating subsequent finishing and sizing operations.

The Tube Welding Machines are usually made right and left hand, in order to allow the grouping of the machines so that when

possible one operator can take care of two machines. The accepted method of driving machines of this type is by means of adjustable speed direct current motors, with field rheostat and push-button station mounted on the machine, the magnetic control panel used for operation in connection with this equipment may be placed at a distance if desired. This equipment provides for forward and reverse motions, together with dynamic breaking, which relieves the operator of the necessity of throwing switches—a simple touch of the correct button automatically taking care of the operation of the machine. The rolls are individually adjustable for alignment, while the welding or compression rolls are in addition adjustable vertically.

On account of usual high speed of the driver, a reduction is made through worm gearing running in oil, and from this point through beveled gearing to the spur gearing, driving the roll equipment. For light gauge tubing, the rolls are placed between housings, the machine being of light construction yet ample for welding tubing much heavier than usually encountered. For changing the roll equipment from one size to another, it is customary to remove one housing, which is arranged with slots for this purpose.

A very important feature is embodied in these machines, in order to make possible the welding of all diameters and gauges under the best possible conditions, that is, the adjustability of the guide roll and housings in relation to the welding rolls; the rapid absorption of heat in light gauge large diameter and small diameter tubes causing more or less distortion in passing from one set of rolls to the other, unless this distance is adjusted to counteract this tendency. The speed of welding the ordinary diameters and gauges of steel tubing is usually performed between 3 and 6 feet per minute; the speed varies as the thickness of metal varies, and to some extent in order to secure particular types of welds. It is the attention to small details, such as mentioned, in the manufacture of machines of this type which makes possible reel automatic welding.

For welding larger diameters and heavier gauges, a Tube Welding Machine is provided which is of very much heavier construction, arranged with all rolls overhung, making possible the changing of rolls from one size to another by simply removing the holding nuts. The same features of adjustability are incorporated in the larger machine; all bearings subjected to heat, however, are water-cooled, it being essential to use torches and tips of much larger capacity in welding at higher speed or heavier walled tubing. While the large machine is primarily intended for welding large diameter heavy gauge tubes, medium diameter light gauge tubes can also be welded at a very much higher speed than possible on the machine previously described.

In addition to the roll equipment usually found on Tube Welding Machines, there are added two additional pairs of compression

rolls whose function is to prevent the rupture of the seam and recompress the metal, which, at higher speed, requires a longer interval of time to drop below the critical temperature due to the greater absorption of heat.

A feature common to both machines, and which is particularly necessary when welding at the higher speeds, is a universal torch adjusting arm which makes possible instantaneous movement of the torch in any direction, as well as movements controlled by thumb screws vertically and radially, together with provision for throwing the torch to a horizontal position for lighting and inspection.

Having a machine which embodies all the essential features and the required accuracy in construction, it is even more important to have an adequate supply of gases at absolutely unvarying pressures, also apparatus for burning the gases with flames so positioned as to take advantage of the physical changes in the tube while undergoing the welding and compressing operation.

All other conditions being constant, the position of the flames in relation to the seam, and particularly the welding rolls, has a decided influence on the character of weld produced.

It is important that an interval sufficient for the solidification of the metal be allowed before the compression occurs, in order to prevent cracking while passing through the machine, therefore the final flame of the torch must be in advance of the center line of the two compression rolls. Any advance beyond a certain point requires more compression and tends to produce heavy welds which are usually undesirable on account of the cost of removing the excess metal.

Almost all tube and mechanical welding operations to-day employ the multiple flame welding tip. These tips may have any number of flames within the capacity (of the machine and work) to absorb the heat produced, to say nothing of the endurance of the person who must operate the machine.

A person who has witnessed a welding machine in operation having a single flame tip in use, undoubtedly noticed the wave formation of the molten metal seemingly traveling ahead of and around the flame, finally solidifying in the rear of the flame, and if the motion was unsteady, leaving wave marks indicating a long tapered wedge shaped puddle.

The wave formation with a multi-flame tip is more pronounced, due to the fact that every flame (which is the result of the combustion of gases under pressure), causes a series of waves, the depth of the hollow and the height of the wave above the actual surface of the metal increasing as the heat is absorbed, and the metal acted upon by each succeeding flame.

The remarks regarding the agitation of the metal due to the velocity of the gases, discloses the reason for the accuracy required in tool equipment used in the production and welding of the tubing,

together with the necessity for absolutely uniform speed and constant gas pressures.

Welded steel tubing made from suitable material with the proper amount of care exercised in its manufacture as outlined, will go through the usual crushing, flanging, expanding, bending and other tests usually performed on seamless and lap welded tubing in order to indicate its qualities.

Welded tubing is usually finished by grinding to remove all evidence of the weld and produce a tube of uniform contour, this grinding operation being performed preferably on a motor driven grinding machine, arranged for two operators working simultaneously, and with foot treadles controlling the necessary pressure placed upon the tube to quickly remove the surplus metal. The usual practice is to have the machine equipped with flexible buffs, coated with abrasive, and with the periphery curved so that when a tube is placed in the machine at an angle of approximately 30°, the wheel covers a considerable portion of the space and thereby prevents the grinding of flat and irregular spots on the surface of the tube; the operation being that of moving the tube backward and forward so that the operator can continually see the condition of the tube he is working on. When the tubing is welded with the idea of producing a strong weld with the least possible amount of finishing required, it is not uncommon for an operator to grind 4000 or 5000 feet of tubing per day. After grinding, the tube is ready for the finishing operation, which may be either swaging or drawing.

The Swaging Machine is of the rotary type, which embodies a hardened steel ring pressed into the head of the machine, inside of which there are a number of rolls, usually ten or twelve, these rolls being mounted in a steel cage which is free to rotate, while inside of the rolls there is the arbor of the machine which, at this end, is slotted in order to accommodate the dies and the hammers which are machined to the proper form so that when thrown out by centrifugal force are brought into contact with the rolls, and due to their form pass from one roll to the other with a smooth rolling action, thereby producing on the dies which are between these hammers a squeezing action, rather than a hammer blow, each contact with the rolls producing a slight rotation of the cage carrying the rolls.

The action of this machine is decidedly different from that in which the cage is stationary, resulting in a series of very powerful blows which is destructive to the rolls and hammers. The dies oscillate, due to centrifugal force with the hammers, and thereby produce a succession of squeezes varying between 3000 and 5000 per foot, depending on the size of the machine and the speed at which it operates. The over sized tubing as delivered from the Tube Welding Machine is compressed with an accuracy equal to the ac-

curacy of the dies, and with a finish which is very much smoother than is usually possible with the Draw Bench.

The swaging speed on full length tubing will usually be in the neighborhood of 30 to 40 feet per minute. The Swaging Machine is used oftentimes in conjunction with the Draw Bench in order to reduce the diameter of the tube sufficiently to pass through the dies so that the dog of the Draw Bench can grip it. The Swaging Machine, when equipped with formed dies, is used very extensively for swaging tubes which are to be tapered or changed in form. It is sometimes necessary to perform an operation of this kind by passing the tube through successive dies in order to produce the final form. If tubing is required to be brought to accurate dimensions externally and internally, the operation must be performed on the Draw Bench, and for this purpose the Draw Bench is usually fitted with what is termed a back bench. This is an extension of the bench in order to provide support for a rod which is termed the triblet rod, and carries on its end a hardened steel plug which is the exact internal dimension of the tube. This dimension being considerably smaller than the tube allows for the tube to be passed over the plug, previously lubricating the plug and tube, and when entered in the die or dies is drawn down to finished dimension passing through the annular space between the triblet and the die, thereby being brought to proper dimension both internally and externally. Sometimes it is necessary to perform this in more than one operation, if the reduction required is excessive.

The drawing speed with properly lubricated dies is usually in the neighborhood of 40 lineal feet per minute, the machine always requiring two men for maximum production. When equipped with a roller die head the drawing of various shapes of tubing from round tubing is possible, squares and rectangles being most common.

Tubes coming from the swaging and drawing operations are never absolutely straight and must be straightened, which is usually accomplished in a Straightening Machine, or in some cases by hand straightening over a block in the usual manner. The Straightening Machine, however, makes possible very much larger production at less cost and produces uniformly straight tubing without danger of kinking or flattening. This machine is usually of the ten or twelve roll type, with two sets of rolls at right angles to each other, three rolls in each case being power driven, with the final roll in each set adjustable, as are the two idlers. This arrangement simplifies the straightening operation and makes possible the straightening of tubes at speeds of 100 to 200 feet per minute, depending on the size.

After the swaging and drawing operations the crop ends, if any, are removed from the tubes by the Tube Cutting Machine which carries a swinging high speed saw, belted to a motor, the motor being mounted on the base of the swinging head carrying the saw.

The saw used is a special saw for cutting soft steel at high speed, and is driven at from 3000 to 4000 r.p.m. The saw is actuated by a foot treadle operating through a compound lever which advances the saw, thereby severing the tube. All moving parts above the table are covered by removable guards, and provision is made to discharge the sparks and chips accompanying the cutting operation to the rear of the machine.

There is a demand for steel tubing bent in various ways, and a Tube Bending Machine is usually a part of the equipment of every Tube Welding Plant. Round, rectangular and other shaped tubes can be bent perfectly to any reasonable radius without deforming or wrinkling, the bending operation being in reality a drawing operation, a plug of proper type being used inside of the tube to support the walls while being bent.

The machines are always equipped with clutch pulleys for driving in both directions, and very often with power attachment for entering and withdrawing the plug, considerable power being required for withdrawing the plug after the bend has been completed due to the gripping action of the walls of the tube upon the plug. All the operating levers of the machine are in a convenient position so that one man controls all the motions of the machine, while another is usually employed for feeding the tubes and removing the finished bends.

A different set of tools is required for every change in dimension or radius. These tools are readily mounted on the machine by the removal of four bolts, and the clamping action of the jaws accomplished in various ways to suit the particular requirements. The actual time consumed in making a bend of 90 degrees seldom exceeds eight seconds, the production of 100 to 120 bends per hour being possible. The machine as usually furnished will produce bends up to 180 degrees.

The simplicity of the process of manufacturing welded tubing as described, eliminating the necessity for ponderous equipment of great cost and the numerous operations required to produce a thin walled tube of equal quality, as well as the labor cost involved, makes possible the production of this class of tubing at a fraction of the cost of seamless steel tubing. In fact, a firm using less than a million feet of tubing a year can produce tubing in their own plant for their own consumption in competition with market prices; this is particularly so if his requirement is more or less special.

TECHNICAL QUESTION AND ANSWER COLUMN

From time to time the Society is requested to furnish technical information on various welding problems. This information in many cases is of general interest and in order that it may be available to our members we will publish in the proceedings under the auspices of our research department, The AMERICAN BUREAU OF WELDING, a Technical Question and Answer column. Although the statements given below are expressions of opinion of competent engineers they do not involve the Society or Bureau in any way. The Society does not intend through the medium of this column to solve those welding problems which should fall in the province of a Consulting Engineer.

WELDING TUBES IN BOILERS

Question

In welding the bottom ends of 2½-inch tubes in some Manning boilers, the question has come up as to whether it is advisable to expand the tubes and flare them slightly and weld around the ends of the tube or to bead the tube after expanding and weld over the head?

Answers

The application of welding flues to either the back or front head of steam boilers is one that has been given quite serious thought by a number of men who have associated themselves with arc welding in the past five years, and the writer believes from actual experience that the most efficient way to accomplish this application is as follows:

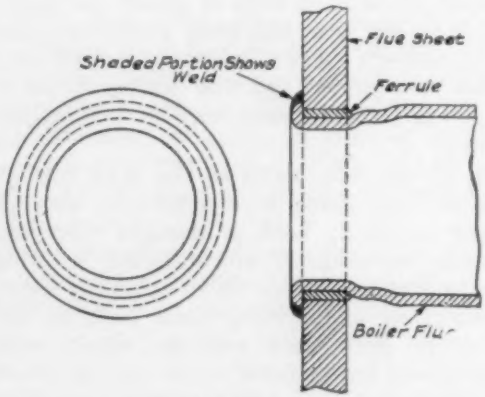
The welding of the flue beads to the back flue sheet is a very important one and too much care cannot be exercised in preparing the flues for welding. Lack of thought when applying copper ferrules has been the cause of more electric welding flue failures than any other known condition. If in applying the copper ferrules attention is not given to inserting them back in the hole at least one-sixteenth of an inch, they will invariably work out toward fire box and protrude under bead when rolling, prossering and expanding of the flue has begun. This causes a condition which seriously prevents the welder from making an efficient weld, as it is a known fact that the welding of copper to steel, except under certain conditions, is not practical and when the flues are subjected to the least working, the metal deposited breaks from the sheet and a failure results.

After the flues are applied in the regular manner, and in the same way that it had been applied prior to the introduction of welding, the boiler should be heated to a testing pressure to absorb any oil or grease that may be on the head or under the bead; then the sheet should be thoroughly sandblasted to remove any dirt that may remain on the head. Sandblasting flues has proved to be the

best way in which to clean the sheet, as it leaves the surface uniform and free from any rust or scale. Cleaning the sheet with a roughing tool serves to brighten the surface but forces back in the sheet the surface scaling which when subjected to the heat of the electric arc works out and becomes part of the weld, creating a spongy deposit and rendering the flue liable to failure. A sand other than that which is used for engine sand should be used when cleaning work preparatory to welding. A white coarse glass sand has proved to be the most serviceable.

In the welding of flues the operator should begin his welding a little to the left or right of bottom center and work up one side to top center, then return, starting again in the original starting point, working to top center and lapping his weld at the point of completion to overcome any pin holes that may have developed in breaking the arc.

Experience has proven that it is a very harmful practice to begin the weld at the top and work to the bottom. The method that has proven most successful for over three years is that the weld should be equally divided on the head and the flue head, similar to figure below. Care should be taken that the weld does not extend over the top of the bead to form a corner in which fire cracks will develop.



Welding flues in boilers.

In the case of re-welding old flues (that is, the flues which have been welded that have developed leaks), all old metal should be removed by chipping from the bead to the sheet, then flue should be rebeaded and sandblasted. Do not attempt to remove just a portion of the bead that is leaking, as it has been proven that the life of the metal at that point is gone and a fusion of the old and new metal will not take place.

The practice of applying the flue and belling or flaring over preparatory to welding is a harmful one since it involves a possibility

of the operator burning a considerable portion of the flue and at the same time it exposes to the fire more metal than that which ordinarily the water can keep cool.

B. C. TRACEY,
General Electric Co.

It is practically standard practice with every railroad on this continent to weld the flues in the firebox end, both the large 4-inch ones and the smaller 2¼-inch ones.

In the welding of new flues in a new boiler, the best method possible is to follow your standard practice in inserting these tubes and then weld a light bead on the outer edge, simply to make leaking life three or four years instead of as many months. That is, do not expect the welding to have anything to do with the strength or original tightness of the tube, but roll them, bead them, and if it is your standard practice, prosser them.

The welding of boiler tubes after they have been rolled, beaded and often prossered is the most prevalent example of a single bead fillet for tightness only. Here the tube is secured in place to start, even when a new tube is put into an old flue sheet; generally a ferrule of copper is put in between the new tube end and the old sheet to allow for the difference in size caused by the first or previous expansion. When a copper ferrule is properly applied none of it sticks out beyond the bead, but even if irregular pieces do stick out the sealing weld can be made as usual, as a reasonable amount of copper fuses well with the steel of weld, bead and sheet. The proper cross section of the tube sealing bead should be egg-shaped with the large end, welded in, and there is no need of chipping off the small protruding end, as experience has shown that no scale or soot results. In rolling and beading tubes oil is used, and this oil must be burned out of the sheet so that no trace of it remains under the bead, or in welding the oil gas will bubble out through the weld, causing leaks and no job. The edge of the bead and flue sheet should be cleaned of scale by chipping or sand blast, the latter being the better, but not always available.

C. J. HOLSLAG,
Electric Arc Cutting & Welding Co.

The railroads that have had the greatest success in the welding of flues to the rear flue sheet in locomotive fire box work have followed the practice of inserting the flues in the same manner as formerly used where no welding work was done. In other words, copper gaskets are set in the flue sheet at the end of the flue and the flue is expanded and beaded over. Care must be exercised to see that the copper ferrule does not extend beyond the edge of the

bead, otherwise it will cause trouble in the welding work. Before the welding operation is started in many shops where the most successful work is accomplished, the locomotive boiler is filled with water at a moderate temperature. The operator then does the welding work around each flue, starting in at the bottom edge of the flue and working up to the top, then breaking the arc and starting in at the bottom again and working around the other side of the flue, completing the weld at the top.

When performing this welding work it is customary to use a 5/32-inch diameter mild steel welding wire and a current value of approximately 150 to 160 amperes where the boiler is filled with water. If the welding, however, is done without water in the boiler, then the best results are usually obtained by using ⅛-inch diameter mild steel welding wire and using a current value of approximately 125 amperes.

A. M. CANDY,
Westinghouse Elec. & Mfg. Co.

Standard Locomotive practice is to set the flue with copper ferrule as usual, but taking care not to let the copper project far enough to come from under the bead, as copper will not weld, and after beading, run a single fillet all around the bead and sheet. Use ⅛-inch wire and about 130 amperes, being sure to get good biting into the sheet.

Weld one flue and go to the other side of the sheet and weld another, that is, scatter the welding so as to avoid too much heat at one time in one place.

Electric welding is better for this work than gas welding.

S. W. MILLER,
Rochester Welding Works.

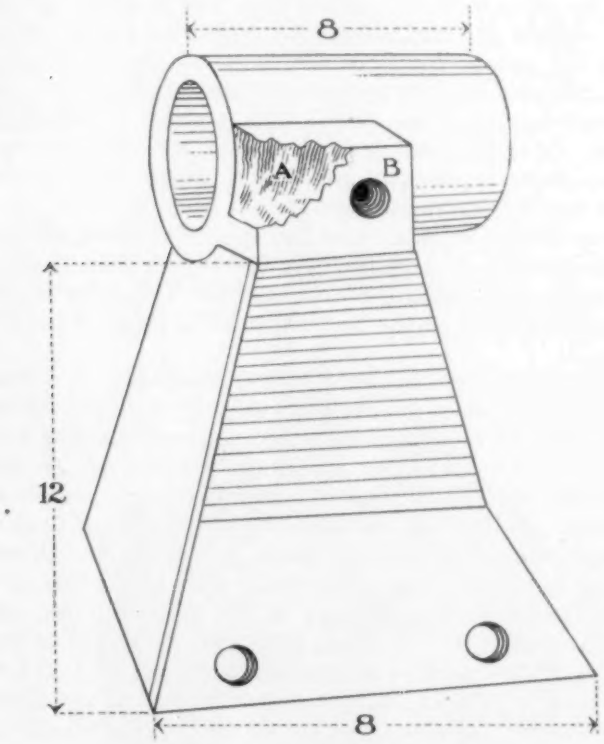
DISCUSSION OF PAPERS—CAST IRON WELDING

By L J CULLEN*

IN the past cast iron at the Port Richmond Plant of the Staten Island Shipbuilding Co. has been welded by the stud system with steel filler material, but without any brilliant results. Acetylene therefore required almost a monopoly of this particular line of welding. A few months ago we secured a new type of electrode, namely, Monel Metal, and have since used it to the exclusion of acetylene. I am describing below a job which we did recently and which I think will be of interest to the members of the society, especially after having read Mr. Allard's article. This particular job

*Discussion of A. R. Allard's paper on Arc Welding of Cast Iron, appearing in January, 1922, issue of Journal of American Welding Society.

was a cast iron bracket of a control valve shaft on the S.S. "El Capitan." A sketch of this work is shown in figure below. The diameter of electrode was 5/32 in. and 150 amperes were used. Studs were unnecessary and the weld was accomplished by running a succession of small beads and peaning after each 2-in. bead. At the start of the weld a fuller tool was used for peaning. The casting was not preheated, but upon completion was wrapped in asbestos paper and allowed to cool slowly.



Repairing cast iron bracket

Mr. Allard, in illustration No. 5, shows a steel deposit upon a block of cast iron. This deposit consists of a layer of 5 beads which I roughly estimate to be about ¾ to 1 in. thick. The illustration plainly shows the separation of the added metal from the cast iron. I have always found this to happen, especially when depositing a large amount of metal from a steel electrode upon cast iron. The monel electrode, which was used, is a flux coated wire and at no point did the added metal separate itself from the cast iron. The completed casting was very easily machined, not a tool being broken, as has been nearly always the case in the past

when machining deposited metal from a steel electrode. The second hole was drilled and tapped in the deposit and the finished job showed perfect fusion, not even the customary gas pockets and holes appearing.

WELDING A CHILLED CAST IRON ROLL

C. J. HOLSLAG

The writer encounters the prevailing notion about the country that in the electric arc welding of cast iron, studding is resorted to to entangle the parent metal in the metal of the weld, similar to the wooden skewer stuck in a piece of meat prepared for roasting. Such is absolutely not the case. This method of studding was thought out, designed and developed, and my engineering spirit resents the inference that the studs are placed there to function in the same way as the pegs in a shoe.

The correct design of studs and the theory of their use was presented by the author in a paper read before the Metropolitan Section of the American Welding Society at New York City on January 18, 1921, and published in the February, 1921, issue of the *Welding Engineer*.

The use of a copper-nickel alloy, either plain Monel metal, or as we have found out one of its derivatives, with a copper-nickel content, enables one to weld cast iron cold, without leaving any hard layer or spots. While this alloy gives a weld which has the strength of steel, the deposited metal may include gas bubbles and pockets, and in order to keep this out, the welding must be done very slowly, which, together with the cost of the nickel electrode, almost prohibits its use for large jobs. Our method of using this desirable alloy is to fill in the first layer with it, and the last layer, and perhaps the joints, or a spot where a hole is to be drilled so that the machineable qualities will be as desired, together with the rugged strength of steel welded to studded cast iron, and at the same time 98 per cent of the deposited metal can be the reasonably priced steel.

We recently had the opportunity of carrying many of our theories on cast iron welding into actual practice in the welding of a chilled cast iron roll.

This roll was about 5′ long by 22″ in diameter. There were two bearings, one on each end about 18″ long by 14″ in diameter, and two extensions on the ends of these bearings for the gear fits, which were about 15″ long and 11″ in diameter. The break occurred at the end of the bearing between the bearing and the main piece. The break was clean, that is, there were no defects in the cast iron, having evidently been caused by the main roll becoming jammed tight with the rest of the machinery in motion. As this roll was

steam-heated for rubber work, the joint had to be steam tight as well as strong.

The method of veeing out was to take the smaller part, the bearing and the gear fit, put it in the lathe and turn it down to approximately a 45 degree angle. As the roll was chilled on the outside, this was not a straight line, but tapered more in the center, where the metal was softer and less at the two edges. The main part of the shoulder was cut off to approximate a V by the use of the electric arc with about 600 amperes, and this made a nice chilled surface, even more chilled than the outside of the roll itself, which renders welding easy. This chilled surface, however, had to be chipped off in spots where the studs were to be placed. There were three rows of studs on each of the surfaces to be welded, studs placed about 2½ to 3″ apart and the rows staggered. With a steel

Fig. 1—Welding a Chilled Cast Iron Roll.

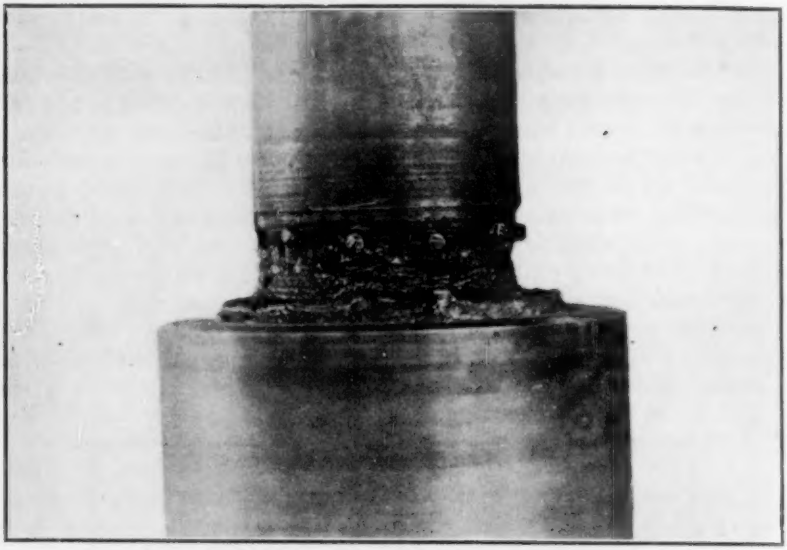


Fig. 2

electrode especially adapted for cast iron welding, each of these studs was merged into the face of the V before the parts were put together, so that the entire surface to be welded was practically covered with steel before starting to line up.

The lining up was done by setting the roll on end and lowering the smaller part with triplex block into place, holding straight edges on two sides, 90 degrees from each other until the alignment was practically perfect. As all welders know, the first few minutes of the joining of a large piece like this determines whether the job is to be in line or sadly out of line, due to the pulling of this first deposited metal. Due to the chill, there was no chance of re-machining, and it simply had to be perfect as it left the welding operation. These first few deposits were made by two men, one at each side simultaneously joining the steel-faced cast iron parts. These men welded 180 degrees apart and then 180 degrees apart again, 90 degrees from the first weld. After these first V's were put in the piece was found to have lost its original alignment by about 3/32 of an inch. By a combination of welding on the side to be pulled down and driving in chisels on the other side, this was brought back perfect at a time when enough metal was deposited and cooled so that there could be no further distortion due to the welding metal being less than the section already deposited and cooled.

From now on the job was easy, simply running beads around parallel to the circumference of the roll, as is shown by the photograph. The reason for running parallel instead of across the

break is obvious because of the lesser expansion and contraction of the width of the bead than the length of the bead. The metal was built up approximately to size with the special steel electrodes mentioned. The edges where the weld would be joined to the original chilled surface, both on the bearings and on the main roll, being left unwelded. This was finished in with a special copper nickel electrode which has the property of being machineable when deposited cold. This allowed the large roll to be set up in a large lathe and lined up for the bearing that must be turned true. The welds, both the copper nickel and the steel, were cut down to the original size and dimensions, both on the bearing face and on the vertical face, which was a shoulder on the main roll.

By using the copper nickel in this manner at the joint and last layer, the entire job was machineable, as the only part of the special steel welded deposited metal that would not be machineable is that next to the cast iron, and this was submerged for all the welding except the edges where the copper nickel alloy was used.

Now as to the theories involved. First, that studding allows arc welding to really weld to the cast iron and not, as some people claim, only to the studs. If this weld would have been a true weld only to the steel studs, the steam would have naturally leaked out of both joints, the one between the bearing and the one on the main roll, but by use of the studs to make the stretch come in the steel weld instead of the cast iron or along the edge of the joint, the weld of the steel to the cast iron held throughout. Second, the theory that chilled cast iron could be welded was borne out by this job, as the whole job itself was chilled and the edge that was cut by the arc was especially hard chilled. Third, the theory of welding parallel instead of across the break, in order to lessen the resultant expansion and contraction of each bead, worked out beautifully in this instance. Fourth, the work was done by two men with all the speed possible, using a 5/32″ electrode, and yet the chilling was not spoiled at any part on the roll or bearings.

We are quite proud of jobs of this nature where a weld is made that is chilled hard at one spot and perfectly machineable at the other bearing end.

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Aluminum Welding. Fluxes. H. V. A. Briscoe, Brit. Pat. 170343. Ill. Off. Jnl. (Dec. 7, 1921), 5511. 100 w.

Autogeneous Pipe Welding. A. B. Iglehart, Power (Jan. 31, 1922), Vol. 55, pp. 173-4. Before the International Acetylene Association. Methods of Welding Pipes and Results of Tests.

Autogeneous Welding of Aluminum. Autogene Schweissung von Aluminum. T. Kautny, Autog. Metallbearb (Nov. 15, 1921), Vol. 14, pp. 316-9. 700 w. Serial.

Autogeneous Welding of Refrigerating Equipment. J. C. Moran, Power (Jan. 24, 1922), Vol. 5, pp. 145-6. Precautions necessary in the method of welding gas heaters, condensers, oil separators, etc.

Automatic Cutting and Welding Machines. F. E. Rogers, Acetylene Journal (Jan., 1922), Vol. 23, pp. 354. Descriptions are given of the Pyrograph, and camograph. The advantages of a pipe cutting machine.

Electric Arc Welding in Steel Structures. J. Caldwell. Engng. (Jan. 20, 1922), Vol. 113, pp. 88-90. Before South Wales Branch of Inst. of Mech. Engrs. Comparison of cost with riveting. Welding of roof trusses, girders, poles, masts, etc. Description of welding of several large buildings, results of physical tests.

Electric Spot and Seam Welding Tin Plate. W. H. Gibb, Sheet Metal Worker (Jan. 6, 1922), Vol. 12, pp. 850. Why some welds fail. What is necessary to make a successful weld. A brief description of several welding machines.

Electric Welding. Electrical repairing of castings. Die elektrischen Gussreparaturen. E. Mayer, Ztsch. Ges. Geissereipraxis (Dec. 10, 1921), Vol. 42, pp. 653-4. 1000 w.

Electric Welding Apparatus. British Thomson-Houston Co., Ltd., Brit. Pat. 171442. Ill. Off. Jnl. (Dec. 31, 1921), 5917-8. 300 w.

Importance of Managerial Understanding of Welding. T. O. Carter, The Iron Age (Feb. 2, 1922), Vol. 109, pp. 323-4. Study of the conditions necessary to secure the best results and methods of checking welders' ability; tests to determine correct welding; tests of ammonia receivers.

Increasing Welding Speed. H. R. Pennington, Welding Engineer (Jan., 1922), Vol. 7, pp. 24-5. Before the American Welding Society. Discussion on increasing speed of welding by increasing electrode diameter and coating of electrodes.

Joining Bars by Thermit Welding. L. I. Grinnell, Am. Machinist (Jan. 26, 1922), Vol. 56, pp. 132. Welding bars together for making lead screws of rifling machines 64 and 74 ft. long, 4⅝ inches in diameter.

Locomotive Boiler Welding. Welding Engineer (Jan., 1922), Vol. 7, pp. 26-8. Report of Committee of Master Boiler Makers' Association. Description of welding a complete fire box, repairing small portions of side sheet, patching crown sheets, plates, etc., with drawings to illustrate.

Oxy-Acetylene Welding Rods. J. R. Dawson, Welding Engineer (Jan., 1922), pp. 7, 32, 34-7, 40. 4500 w. Before International Acetylene Association, New York.

Points to Watch in Welding of Cast Iron. F. L. Rogers, Canadian Machinery (Jan. 12, 1922), Vol. 27, pp. 26-8. Care required owing to brittleness of the metal. Necessity of using flux to reduce the oxide—shape—mold or dam welding with cuts illustrating the different methods.

Oxygen and Nitrogen in Welds. S. W. Miller, Chem. & Met. Engng. (Jan. 4, 1922), Vol. 26, pp. 27-9. Extracts from a paper read before the American Iron and Steel Institute. The use of the microscope in showing the nature of the defects in welds. Prevention of oxidation.

Progress in Cutting and Welding Acetylene. Min. & Sc. Pr. (Dec. 10, 1921), Vol. 123, pp. 825-6. Report of committee before the International Acetylene Ass'n. A "Code" regulating the construction of pressure vessels. Welding of pipe lines, different metals. Progress of gas welding for the past two years.

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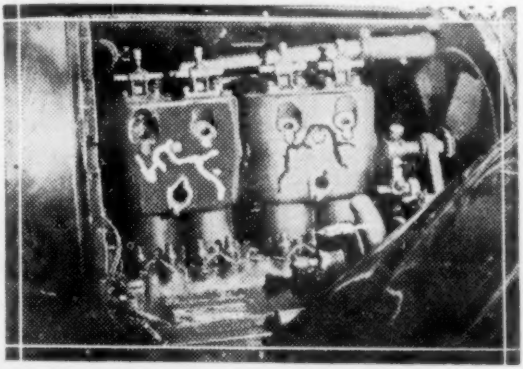

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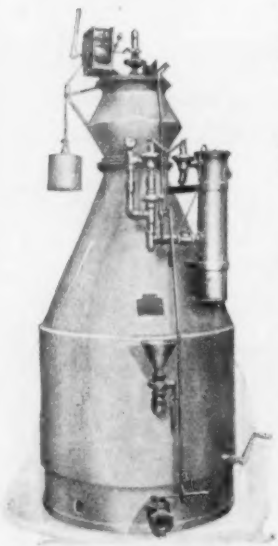

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